AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph beginning at **page 2, line 2**, and insert the following rewritten paragraph:

Thus, technologies disclosed in, for example, Japanese Unexamined Patent Application Publication No. 2002-326173 (patent document 2) and PCT international publication WO/03/057427/A1 (patent document 3) have been proposed by the present applicant. According to the technologies disclosed in these patent documents ~~3 and 4~~2 and 3, an instantaneous desired gait composed of an instantaneous value of a desired motion (instantaneous desired motion) of a robot and an instantaneous value of a desired floor reaction force (instantaneous desired floor reaction force) is sequentially created using a first dynamic model (simplified model), which represents a relationship between motions of the robot (the positions and postures of individual portions) and floor reaction forces, such that a dynamic balance condition (a condition, such as the one in that a translational force component of a floor reaction force takes a desired value or a floor reaction force moment about a certain point takes a desired value) on the first dynamic model is satisfied. Then, the instantaneous desired gait is input to a second dynamic model (full model) wherein a part of the instantaneous desired motion (desired body position/posture, a desired moment about a desired ZMP, or the like) is corrected so as to generate a final instantaneous desired gait in a time series manner.

Please replace the paragraph beginning at **page 6, line 6**, and insert the

following rewritten paragraph:

wherein provided that, in relation to arbitrary time t of the provisional motion, a difference between the floor reaction force moment horizontal component M2(t) generated at the time t on the second dynamic model by the provisional motion and the floor reaction force moment horizontal component M1(t) generated at the time t on the first dynamic model by the provisional motion (M2(t)-M1(t)) is defined as a floor reaction force moment horizontal component error Merr(t), and a difference between the translational floor reaction force horizontal component F2(t) generated at the time t on the second dynamic model by the provisional motion and the translational floor reaction force horizontal component F1(t) generated at the time t on the first dynamic model by the provisional motion (F2(t)-F1(t)) is defined as a translational floor reaction force horizontal component error Ferr(t), then

Please replace the paragraph beginning at **page 13, line 12**, and insert the following rewritten paragraph:

wherein provided that, relative to arbitrary time t of the provisional motion, a difference between the floor reaction force moment horizontal component M2(t) generated at the time t on the second dynamic model by the provisional motion and the desired value MT(t) of the floor reaction force moment horizontal component at the time t (M2(t)-MT(t)) is defined as a floor reaction force moment horizontal component error Merr(t), and a difference between the translational floor reaction force horizontal component F2(t) generated at the time t on the second dynamic

model by the provisional motion and the translational <u>floor reaction </u>force horizontal component F1(t) generated at the time t on the first dynamic model by the provisional motion (F2(t)-F1(t)) is defined as a translational floor reaction force horizontal component error Ferr(t), then

Please replace the paragraph beginning at **page 17, line 18**, and insert the following rewritten paragraph:

wherein provided that, in relation to arbitrary time t of the provisional motion, a difference between ZMP2(t), which is a ZMP calculated at the time t on the second dynamic model from the provisional motion, and ZMP1(t), which is a ZMP calculated at time t on the first dynamic model from the provisional motion, (ZMP2(t)-ZMP1(t)) is defined as a ZMP error ZMPerr(t), and a difference between the translational floor reaction force horizontal component F2(t) generated at the time t on the second dynamic model by the provisional motion and the translational <u>floor reaction </u>force horizontal component F1(t) generated at the time t on the first dynamic model by the provisional motion (F2(t)-F1(t)) is defined as a translational floor reaction force horizontal component error Ferr(t), then

Please replace the paragraph beginning at **page 21, line 7**, and insert the following rewritten paragraph:

Further, a ZMP (referred to as ZMP1'(t) here) obtained by adding the ZMP error ZMPerr(t) or the ZMP correction amount based on the <u>ZMPerr(t)</u>

~~ZMPerrr(t)~~ to a ZMP calculated on the first dynamic model from the desired motion approximates a ZMP calculated on a second dynamic model from the desired motion, so that ZMP1'(t) has high dynamic accuracy on a desired motion. And, as in the case of the first invention, a translational floor reaction force horizontal component F1'(t) obtained by adding the translational floor reaction force horizontal component error Ferr(t) or the floor reaction force correction amount based on the Ferr(t) ~~Ferrr(t)~~ to a translational floor reaction force horizontal component generated on a first dynamic model by the desired motion also has high dynamic accuracy on a desired motion. Therefore, determining a desired motion (correcting a provisional motion) such that these ZMP1'(t) and F1'(t) satisfy the desired ZMP and the permissible range, respectively, makes it possible to generate a desired gait having high dynamic accuracy while properly satisfying the desired ZMP and the permissible range.

Please replace the paragraph beginning at **page 66, line 19**, and insert the following rewritten paragraph:

In the present embodiment, the normal turning gait, which is a cyclic gait, is a gait for two steps of the robot 1. In other words, a gait composed of a first turning gait following the current time's gait and a second turning gait following the first turning gait is defined as the gait for one cycle of the normal turning gait, and the gait for one cycle is repeated. If the current time's gait to be generated is, for example, a running gait for the robot 1 to run (a gait having a one-leg supporting period and a floating period), then the first turning gait and the second turning gait of

the normal turning gait are also running gaits, while if it is a walking gait for the robot 1 to walk (a gait having a one-leg supporting period and a two-leg supporting period), then the first turning gait and the second turning gait of the normal turning gait are also ~~running~~ walking gait. This means that the basic gait mode of the first turning gait and the second turning gait are the same as that of the current time's gait.

Please replace the paragraph beginning at **page 74, line 3**, and insert the following rewritten paragraph:

A body inclination restoring moment ZMP-converted value peak value ZMPrecpeak~~ZMPrecpeek~~ determined in the processing of the flowchart shown in Fig. 12 indicates the peak value of a ZMP-converted value ZMPrec of a floor reaction force moment required for a body posture to approach a reference body posture (the amount of deviation from a desired ZMP providing a reference (a desired ZMP defined by a ZMP trajectory parameter determined in S022)) in a one-leg supporting period of the robot 1 (more specifically, the period from the moment immediately after the start of the one-leg supporting period to the moment immediately before the end thereof; hereinafter, it will be referred to as "the body inclination angle restoring period"), an example thereof being shown in Fig. 19. ZMPrec takes a trapezoidal pattern, as shown in the figure, the peak value thereof (the height of the trapezoid) being denoted by ZMPrecpeak~~ZMPrecpeek~~.

Please replace the paragraph beginning at **page 75, line 17**, and insert the following rewritten paragraph:

Subsequently, in S202, an initial (time Ts) body horizontal position, an initial body horizontal velocity, an initial body posture angular velocity, and the peak value of a body inclination restoring moment ZMP-converted value on the simplified model are taken as search objects, and the candidates (Xs, Vx, ωbs, ZMPrecpeak) ~~ZMPrecpeek)~~ of these search objects are provisionally determined (the initial values of candidate values of the search objects are determined). In this case, the provisionally determined candidate values may be basically arbitrary, and they may be determined on the basis of, for example, the initial states of a normal gait determined when the last time's gait was generated. Incidentally, these values provisionally determined are the values observed in the supporting leg coordinate system of the first turning gait (the aforesaid next time's gait supporting leg coordinate system).

Please replace the paragraph beginning at **page 77, line 14**, and insert the following rewritten paragraph:

Subsequently, in S208, a gait (a provisional normal gait) is generated using the simplified model up to the time Ts+Tcyc (the terminating end of the normal gait) on the basis of the normal gait parameter that includes the candidate values of current search objects, the vertical position and the vertical velocity of the body 3, and ZMPrecpeak~~ZMPrecpeek~~. This processing will be described hereinafter.

Please replace the paragraph beginning at **page 78, line 22**, and insert the

following rewritten paragraph:

Meanwhile, if the determination result of S214 is NO, then the candidates of a plurality of (four in the present embodiment) search objects obtained by changing the values of Xs, Vx, ωbs, and ZMPrecpeak~~ZMPrecpeek~~ by predetermined extremely small amounts ΔXs, ΔVx, Δωbs, and ΔZMPrecpeak~~ΔZMPrecpeek~~ are determined in the vicinity of the candidate values of the current search objects (Xs, Vx, ωbs, ZMPrecpeak~~ZMPrecpeek~~), and the same processing as that of ~~S2088~~ S208to S212 is carried out to determine the boundary condition errors corresponding to the candidates of the individual search objects on the basis of the normal gait parameter that includes the candidates of the individual search objects (the normal gait parameter having the search objects of the normal gait parameter corrected to the newly determined candidates).

Please replace the paragraph beginning at **page 79, line 9**, and insert the following rewritten paragraph:

Subsequently, in S218, the new candidates of the search objects (Xs, Vx, ωbs, ZMPrecpeak)~~ZMPrecpeek)~~ are determined by an exploratory technique, such as the steepest descent method or the simplex method, on the basis of the current (Xs, Vx, ωbs, ZMPrecpeak)~~ZMPrecpeek)~~ and the boundary condition errors corresponding to the individual candidates of the search objects in the vicinity thereof. Then, the processing from S206 is repeated again.

Please replace the paragraph beginning at **page 80, line 16**, and insert the following rewritten paragraph:

As described above, the values of (Xs, Vx, ωbs, ZMPrecpeak), ~~ZMPrecpeek),~~ which are the search objects, are determined such that the boundary condition of the normal gait is satisfied, and the values of the search objects are used to determine the initial state (including an initial divergence component), which is a state (the motion state of the body 3) at the original initial time (time 0).

Please replace the paragraph beginning at **page 95, line 16**, and insert the following rewritten paragraph:

Subsequently, in S502, it is determined whether the current time k at which an instantaneous value of a normal gait is to be created (the time in the normal gait that is being created) is in the body inclination angle restoring period. And, if the current time k is not time within the aforesaid body inclination angle restoring period, that is, if the current time k is in a period from an instant immediately before the end of a one-leg supporting period to an instant immediately after the start of the next one-leg supporting period (a period during which a desired floor reaction force vertical component is zero or in the vicinity of zero), then the processing of S504 to S518 is carried out. In these processing, first, a body horizontal acceleration αtmp attributable to a motion of the aforesaid body translational mode is calculated such that a floor reaction force moment horizontal component –Merr_p(k) obtained by subtracting a current value Merr_p(k) of a floor

reaction force moment error (a floor reaction force moment horizontal component error) from an original desired floor reaction force moment horizontal component (=0) about a desired ZMP is generated on a simplified model (S504). αtmp denotes a provisional value of a body horizontal acceleration in a gait that is being created. Then, a translational floor reaction force horizontal component Fxtmp' obtained by adding a current value Ferr_p(k) of a translational floor reaction force error (a translational floor reaction force horizontal component error) to a translational floor reaction force horizontal component Fxtmp that balances out an inertial force attributable to a horizontal acceleration of the total center-of-gravity of the simplified model (=Fxtmp+Ferr_p(k)) when the body horizontal acceleration is denoted by αtmp is compared with a floor reaction force horizontal component permissible range (S506 to S510). If this comparison reveals that Fxtmp' deviates from the floor reaction force <u>horizontal</u> component permissible range, then a translational floor reaction force horizontal component Fx' to be generated by a motion of the gait that is being created (this Fx' means a desired value of the component obtained by adding Ferr_p(k) to a translational floor reaction force horizontal component generated on the simplified model by the motion of the gait that is being created) is restricted to an upper limit value Fxmax or a lower limit value Fxmin of the floor reaction force horizontal component permissible range, or if Fxtmp' falls within the floor reaction force <u>horizontal</u> component permissible range, then Fxtmp is directly determined as Fx' (S512 to S514).

Please replace the paragraph beginning at **page 99, line 17**, and insert the following rewritten paragraph:

Thus, the body angular acceleration β and the body horizontal acceleration α are determined such that –Merr_p(k) is generated about a desired ZMP while restoring the body posture toward a reference body posture on the simplified model. At the same time, if the body horizontal acceleration is the acceleration α determined as described above, then the translational floor reaction force horizontal component Fx' obtained by adding the current value Ferr_p(k) of a translational floor reaction force error to the floor reaction force horizontal component Fx that balances out an inertial force attributable to a horizontal acceleration of a total center-of-gravity on the simplified model is determined as a translational floor reaction force horizontal component truly generated by a motion of a gait that is being created. If the current time k is time within the aforesaid body inclination angle restoring period, then a floor reaction force horizontal component permissible range is sufficiently wide, so that the translational floor reaction force horizontal component Fx' determined as described above will not deviate from the permissible range. For this reason, Fx' is not compared with a floor reaction force horizontal component permissible range in the processing of ~~SS520~~ S520 to S530.

Please replace the paragraph beginning at **page 106, line 3**, and insert the following rewritten paragraph:

The processing shown in Fig. 17 will be schematically explained. A ZMP correcting parameter "a", which is the parameter defining a ZMP correction amount, and a first peak value ZMPrecpeaka~~ZMPrecpeeka~~ and a second peak value

ZMPrecpeakb~~ZMPrecpeekb~~ of the body inclination restoring moment ZMP-converted value are determined in the exploratory manner such that the terminal divergence component of the current time's gait agrees or substantially agrees with the initial divergence component of a normal gait (such that the current time's gait connects to the normal gait) on the simplified model. Here, the first peak value ZMPrecpeaka~~ZMPrecpeeka~~ and a second peak value ZMPrecpeakb~~ZMPrecpeekb~~ of the body inclination restoring moment ZMP-converted value determined in the processing of Fig. 17 indicate two peak values of a pattern of a ZMP-converted value of a floor reaction force moment required to bring a body posture close to a reference body posture in the body inclination angle restoring period [Ta, Tb] of the current time's gait, an example thereof being shown in Fig. 20. There has been only one peak value of a body inclination restoring moment ZMP-converted value in the case of a normal gait; in the present embodiment, however, the first peak value ZMPrecpeaka~~ZMPrecpeeka~~ and the second peak value ZMPrecpeakb~~ZMPrecpeekb~~ are used as two adjustable parameters of the body inclination restoring moment ZMP-converted value in order to make the body posture angle and the angular velocity thereof at the end of the current time's gait agree with the initial body posture angle and the angular velocity thereof, respectively, of a normal gait. In the present embodiment, as shown in Fig. 20, the body inclination restoring moment ZMP-converted value in the current time's gait takes a pattern having a shape combining a trapezoidal pattern in the first half of a one-leg supporting period and another trapezoidal pattern in the latter half thereof, the peak value of the trapezoidal pattern of the first half being the first peak value ZMPrecpeaka ~~ZMPrecpeeka~~ and the peak value of the trapezoidal pattern of the latter half being the second peak value

ZMPrecpeakb~~ZMPrecpeekb~~.

Please replace the paragraph beginning at **page 107, line 26**, and insert the following rewritten paragraph:

The processing of Fig. 17 will be explained in more detail. First, in S700, the initial candidates of the values of “a”, ZMPrecpeaka and ZMPrecpeakb, ~~ZMPrecpeeka and ZMPrecpeekb,~~ which are search objects, on the simplified model are provisionally determined. In this case, the initial candidates may be basically arbitrary or they may be determined, for example, on the basis of the values of “a”, ZMPrecpeaka and ZMPrecpeakb~~ZMPrecpeeka and ZMPrecpeekb~~ or the like that have been finally determined when creating a last time’s gait.

Please replace the paragraph beginning at **page 108, line 8**, and insert the following rewritten paragraph:

Subsequently, the loop processing of S704 to S714 is carried out. The processing will be schematically explained. First, in S704, a current time’s gait (provisional current time’s gait) is calculated using the current candidate values of “a”, ZMPrecpeaka, and ZMPrecpeakb, ~~ZMPrecpeeka, and ZMPrecpeekb,~~ which are search objects, and the simplified model. More specifically, the provisional current time’s gait is calculated using a current time’s gait parameter composed of a ZMP trajectory parameter that has been corrected on the basis of the current value of the ZMP correcting parameter “a”, the current values of ZMPrecpeaka and

ZMPrecpeakb, ~~ZMPrecpeeka and ZMPrecpeekb,~~ and parameters other than the ZMP trajectory parameter determined in S026 (a foot trajectory parameter, a floor reaction force vertical component trajectory parameter, etc.), and the simplified model. More specific processing of S704 will be discussed hereinafter.

Please replace the paragraph beginning at **page 108, line 25**, and insert the following rewritten paragraph:

Then, in S706 to S716, the difference between the divergence component at the terminating end of the provisional current time's gait calculated in S704 (the time at which the foot of a free leg of the current time's gait is expected to land) and the initial divergence component q" of a normal gait (the component finally calculated in the aforesaid S024), the difference between the body posture angle at the terminating end of the provisional current time's gait and the initial body posture angle of the normal gait (the posture angle finally calculated in the aforesaid S024), and the difference between the angular velocity of the body posture angle at the terminating end of the provisional current time's gait and the initial posture angular velocity of the normal gait (the angular velocity finally calculated in the aforesaid in the aforesaid S024) are determined. Then, it is determined whether all the values of these differences satisfy a condition in that they fall within permissible ranges (whether they are in the vicinity of zero), and if they do not satisfy the condition, then the values of the search objects are changed. This is repeated to eventually determine "a", ZMPrecpeaka and ZMPrecpeakb~~ZMPrecpeeka and ZMPrecpeekb~~ as the corrected values of a gait parameter that allows the provisional current time's gait

to connect to the normal gait on the simplified model.

Please replace the paragraph beginning at **page 111, line 5**, and insert the following rewritten paragraph:

Meanwhile, if the determination result in S712 is NO, then the candidates of a plurality of (three in the present embodiment) search objects obtained by changing the values of the individual parameters by predetermined extremely small amounts Δa, ΔZMPrecpeaka, and ΔZMPrecpeakb~~ΔZMPrecpeeka, and ΔZMPrecpeekb~~ are determined in the vicinity of the candidate values of the current search objects ("a", ZMPrecpeaka, ZMPrecpeakb),~~ZMPrecpeeka, ZMPrecpeekb),~~ and the same processing as that of S704 to S710 is carried out on the basis of the current time's gait parameters, which include the candidates of the individual search objects, to determine a set of errors (errq, θberr, ωberr) associated with each search object candidate.

Please replace the paragraph beginning at **page 111, line 17**, and insert the following rewritten paragraph:

Subsequently, in S716, the new candidates of the search objects ("a", ZMPrecpeaka, ZMPrecpeakb)~~ZMPrecpeeka, ZMPrecpeekb)~~ are determined by an exploratory technique, such as the steepest descent method or the simplex method, on the basis of the current candidates of the search objects ("a", ZMPrecpeaka, ZMPrecpeakb) ~~ZMPrecpeeka, ZMPrecpeekb)~~ and the sets of errors (errq, θberr,

ωberr) associated with the candidates of the search objects in the vicinity thereof. Then, the processing from S704 is repeated again.

Please replace the paragraph beginning at **page 111, line 26**, and insert the following rewritten paragraph:

As described above, the current time's gait parameter is determined in the exploratory manner such that a current time's gait connects to a normal gait, ("a", ZMPrecpeaka, ZMPrecpeakb) ~~ZMPrecpeeka, ZMPrecpeekb)~~ being the search objects.

Please replace the paragraph beginning at **page 114, line 24**, and insert the following rewritten paragraph:

Accordingly, the provisional current time's gait lastly generated in S028 will be a gait that connects to a normal gait (satisfy the boundary condition of the current time's gait) while satisfying a desired ZMP and a floor reaction force horizontal component permissible range on a semi-full model. At this time, the provisional current time's gait is generated on the basis of the dynamics of the simplified model, taking into account the error Merr_p(k) and Ferr_p(k) of a floor reaction force on the simplified model. Further, an instantaneous value of the current time's gait at each time k is generated by adding a correction based on Merr_p(k) and Ferr_p(k) at that time. This makes it possible to promptly and efficiently determine the gait parameters ("a", ZMPrecpeaka, and ZMPrecpeakb)

~~ZMPrecpeeka, and ZMPrecpeekb)~~ of the current time's gait in an exploratory manner without causing a motion of the gait to diverge.

Please replace the paragraph beginning at **page 119, line 9**, and insert the following rewritten paragraph:

Similarly, the current time's gait lastly generated by the processing of S028 of Fig. ~~109~~ 10 or the current time's gait generated by the processing of S032 corresponds to the desired gait in the first invention or the second invention described above. In this case, in association with the final normal gait, the motion of the normal gait created by the processing of S800 to S810 of Fig. 18 in the processing of S028 corresponds to the provisional motion in the first or the second invention, and the processing of S800 to S810 corresponds to the provisional motion creating means in the first invention or the second invention described above. And, the processing of S818 to S824 of Fig. 18 corresponds to the provisional motion correcting means in the first invention or the second invention. More specifically, in S415 of Fig. 14 in the processing of S822, the embodiment in which the floor reaction force moment horizontal component Msmpl(k) about a desired ZMP generated on the simplified model by a desired motion is actually calculated by the computation of the simplified model corresponds to the first invention, while the embodiment in which the aforesaid expression 3a is used to determine the Msmpl(k) corresponds to the second invention.